

A New Species of *Chirixalus* (Anura: Rhacophoridae) from Western Myanmar (Burma)

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A new species of the rhacophorid genus *Chirixalus* is described from western Myanmar. As with other members of *Chirixalus*, this species possesses a hand in which the two outer fingers oppose the inner fingers. This species differs from other members of this genus by a dorsal pattern of many dark brown spots on a lighter background of the head, trunk, and legs.

Chirixalus is a relatively small genus of 13 species from Asia (Frost 2002). Members of this genus closely resemble species of *Philautus*, except that they possess opposable fingers (Boulenger 1893). Of the 13 species, three are known from Myanmar (*Chirixalus doriae*, *C. nongkhorensis*, and *C. vittatus*). Here, we report a fourth species collected in June of 2001 in western Myanmar near the Bay of Bengal (Fig 1).

Specimens are housed in the collection of the Department of Herpetology, California Academy of Sciences (CAS), the Myanmar Biodiversity Museum (MBM), and the Division of Amphibians and Reptiles, National Museum of Natural History, Smithsonian Institution (USNM). Museum acronyms follow Leviton et al. (1985). Tissues were removed from some specimens, then all were fixed in 10% buffered formalin before preserving in 70% ethanol. Latitude and longitude were recorded with a Garmin 12 GPS, set to datum WGS84.

The preserved specimens were examined, measured, and compared with available specimens and all published descriptions of currently recognized (Frost 2002) species of *Chirixalus* (Boulenger 1887, 1893; Boettger 1895; Annandale 1915; Smith 1924; Cochran 1927; Bourret 1942; Smith 1953; Roonwal and Kripalani 1961; Kuramoto and Wang 1987; Chanda and Ghosh 1989; Ray 1992). Measurements were taken using dial calipers to the nearest 0.1 mm as follows: snout-vent length (SVL); head length (HL); head width (HW); internarial distance (IND); interorbital distance (IOD); snout length (SL); distance from nostril to eye (DNE); forelimb length (FLL); hand length (HLT); thigh length (THL); tibia length (TIL); foot length (FL); width of disk of third finger (3FDW); and width of disk of fourth toe (4TDW).

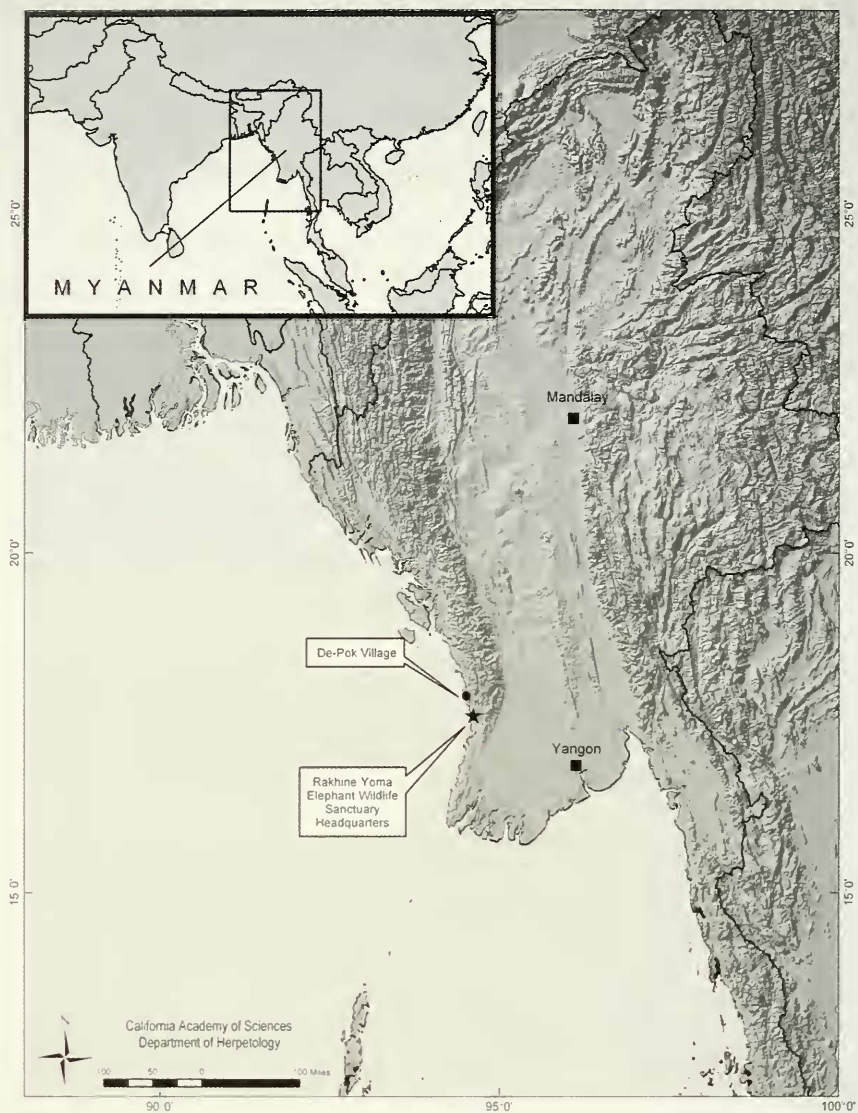


FIGURE 1. Distribution of *Chirixalus punctatus* in Myanmar with type locality indicated by a star.

SPECIES DESCRIPTION

Chirixalus punctatus Wilkinson, sp. nov.
Myanmar spotted treefrog

DIAGNOSIS.— Because *Chirixalus punctatus* is a relatively small frog that possesses expanded discs on the fingers and toes, an intercalary element between the penultimate and terminal phalanges, a flange on the distal end of the third metacarpal, and opposable fingers, it has been placed within *Chirixalus*. It can be distinguished from all other species of *Chirixalus* by a relatively uniform pattern of dark brown spots on a lighter ground color of the dorsal aspect of the head, trunk,

and legs. In addition, *C. punctatus* differs from all other Myanmar species of *Chirixalus* as follows: from *C. doriae* by an indistinct tympanum, a more pointed and elevated snout (Fig. 3), an external vocal sac, webbing only at the base of the third and fourth fingers and absence of webbing on the remainder, and the absence of dark stripes along the head and dorsum (Fig. 4); from *C. nongkhorensis* by the absence of a prominence at the end of the snout (Fig. 3), the absence of small tubercles on the dorsum, the absence of striping on the dorsal aspect of the thighs (Fig. 5), an indistinct canthus rostralis, and an indistinct tympanum; and from *C. vittatus* by a stockier body, a broader head, and larger toe pads (Fig. 6).

HOLOTYPE.— CAS 221555 (Fig. 2), an adult male, collected at the Rakhine Yoma Elephant Wildlife Sanctuary Headquarters (17°36'48.8" N, 94°36'50.2" E), Gwa, Gwa Township, Rakhine State, Myanmar, collected 3 June 2001 by Htun Win, Thin Thin, Kyi Soe Lwin, and Awan Khwi Shein.

DESCRIPTION OF HOLOTYPE.— Habitus moderately stocky; 22.9 mm SVL; head as long as broad, head length 33.8% of SVL; head width 34.5% of SVL; snout pointed in lateral view (Fig. 3), slightly longer than the diameter of the eye, sloping anteroventrally, projecting beyond the mouth; canthus rostralis is rounded, not distinct; loreal region is slightly oblique and concave; nostrils are slightly protuberant and nearer to the tip of the snout than the eye; internarial space is slightly smaller than interorbital space; interorbital space is wider than upper eyelid; eyes are moderately large, diameter of eye 41% of head length; tympanum not distinct, slightly dorsoventrally oval with slight posterior inclination, less than half the diameter of eye; tympanic annulus anteroventrally raised, obscured posterodorsally by slightly raised supratympanic fold.

Vomerine teeth absent; choanae oval partially hidden by edge of jaw when viewed ventrally; tongue, attached anteriorly, V-shaped notch posteriorly; external vocal sac and vocal slits present; premaxilla and maxilla with minute straight teeth.

Third finger longest; followed by the fourth finger, second finger, and the first finger is the shortest; expanded disks on fingers with circummarginal grooves; disk on the third finger largest, approximately the same size as the tympanum; the webbing between the first and second, and second and third fingers is absent, between the third and fourth fingers only at base; the two outer fingers distinctly separated from the two inner fingers (opposable); subarticular tubercles between penultimate and adjoining proximal phalange oval and well developed.

Hindlimbs relatively short, the tibio-tarsal articulation reaches to between the eye and the tip of the snout; heels overlapping when thighs and tibia are placed at right angles to body; length of tibia 51.4% of SVL; foot length 45.1% of SVL; fourth toe longest, fifth toe a little longer than third, second much shorter than third and slightly longer than first; all toes with disks with circummarginal grooves, a little smaller than those of fingers; the webbing on the toes extends to more than two-thirds the length of the toe with a webbing pattern of I 11/2-2 II 1-2 III 1-2 IV 2-11/2 V following Myers and Duellman (1982); the subarticular tubercles are moderately developed (oval); the inner metatarsal tubercle is small indistinct and oval; no outer metatarsal tubercle. The skin on



FIGURE 2. The holotype of *Chirixalus punctatus* (CAS 221555).

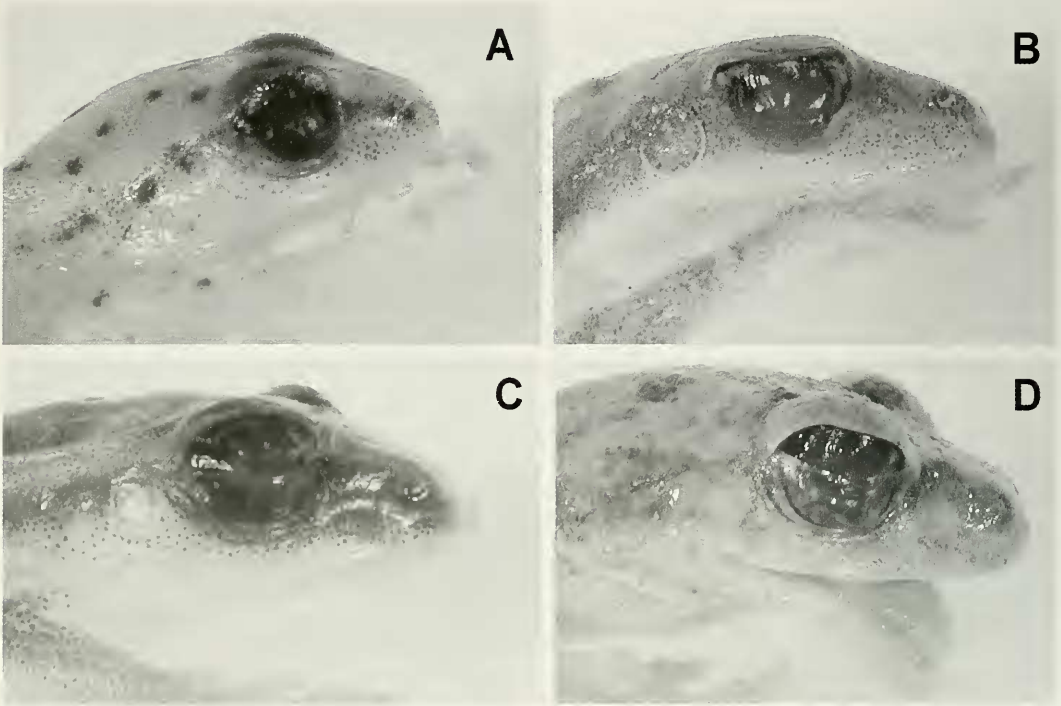


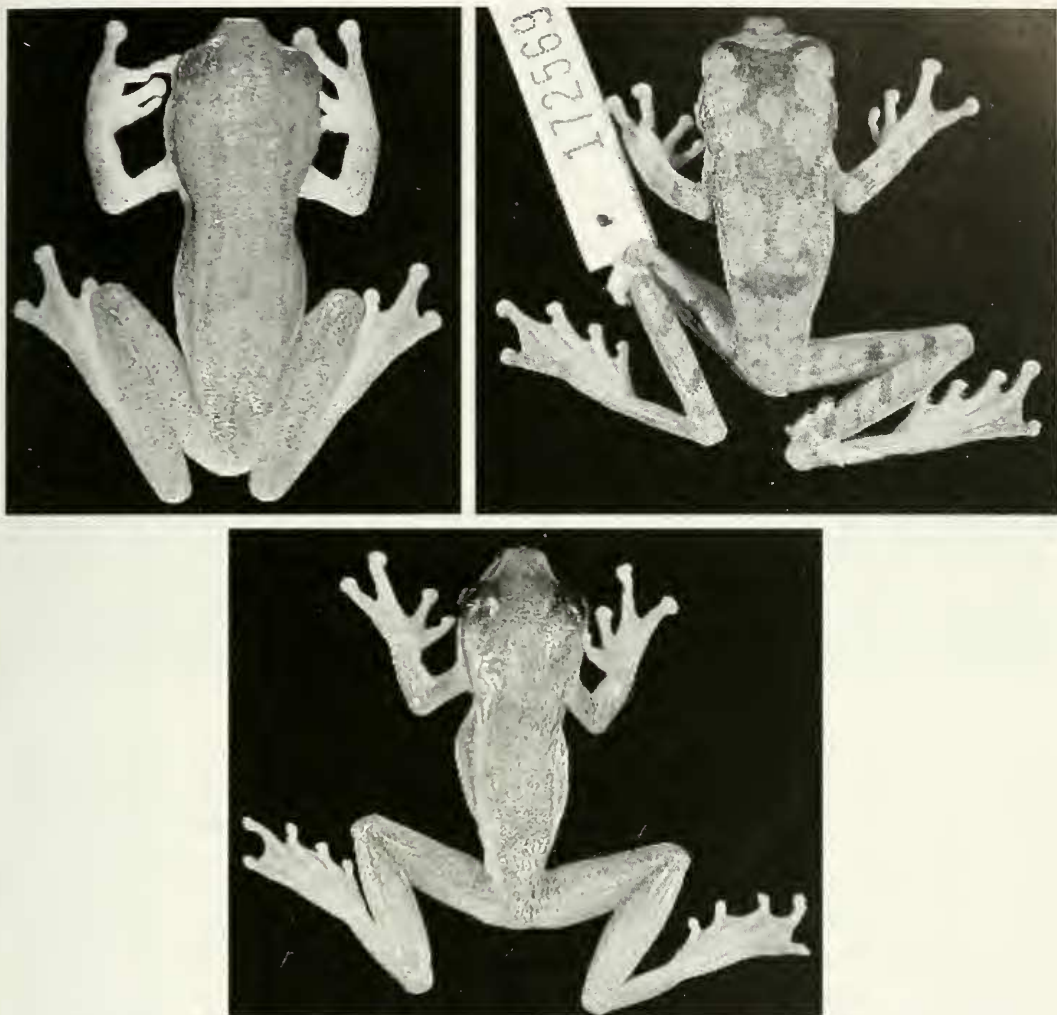
FIGURE 3. Lateral views of the heads of A) *Chirixalus punctatus* (CAS 221555), B) *C. doriae* (CAS 210088), C) *C. viratus* (CAS 221114), and D) *C. nongkhorensis* (FMNH 172569).

the dorsum is smooth, on the throat with small granules, on the abdomen and underside of thighs with larger granules.

COLORATION IN ALCOHOL.— A uniform pattern of minute dark flecks with larger dark (brown) spotting on a lighter background over the head, dorsum, and legs. spotting merges together to form a broken line from snout to eye across the canthus rostralis and from the eye dorsolaterally to groin; a light dorsolateral stripe beginning well behind the eye and ending well before the hindlimbs; there is no pattern or striping on the legs or groin.

VARIATION.— The females are larger than the males (Table 1) but the tibio-tarsal articulation reaches only to the posterior end of the eye, whereas, in the males it reaches to the eye or between the eye and the tip of the snout. The tympanum is more obscure in some individuals than in others. Also, the amount of spotting varies, being sparser in some individuals, restricted primarily to the dorsal aspect of the head whereas in others to the entire dorsum. In some individuals, there is no merging together of the spots to form a broken dorsolateral line from the eye to the groin and no light dorsolateral stripe after preservation, as in the holotype. In life [based on a color transparency of a paratype (JBS 9274); Fig. 7], the dorsal color is a yellowish brown and the ventrum is brownish pink; a pale yellow dorsolateral stripe extends from the snout to just before the vent; the iris is bicolored, with a light upper color meeting the dorsolateral stripe as if the stripe extends through the eye; the fingers are a lighter yellowish brown appearing almost translucent. After preservation in ethanol the dorsal and ventral ground color is white and the dorsolateral stripe fades.

ETYMOLOGY.— The name *punctatus*, from the Latin meaning of having spots, because of the dorsal spotting that distinguishes this species from all other species of *Chirixalus*.



FIGURES 4–6. Dorsal views of (4) *Chirixalus doriae* (CAS 210088); (5) *Chirixalus nongkhorensis* (FMNH 172569); (6) *Chirixalus vittatus* (CAS 221114).

DISTRIBUTION AND NATURAL HISTORY.— At present, *Chirixalus punctatus* is known only from the southwestern foothills of Rakhine Yoma, Gwa Township, Rakhine State, in western Myanmar (Fig. 1). All individuals were found in disturbed habitat between mountain evergreen forests and agricultural land, 1 to 2 m off the ground in bushes. Searches of the evergreen forests failed to find any individuals. The males were calling at the time of collection. The call consisted of a series of a short “dat” separated by 3–4 second intervals. Amplectant pairs were also observed in the plants, where the female would select an oviposition site to build a foam nest for egg deposition on leaves overhanging standing water. The foam nests were found only in a particular plant of the genus *Arum* in the family Araceae.

Other frogs collected in the vicinity of the localities of *Chirixalus punctatus* were *Amolops* sp., *C. nongkhorensis*, *Occidozyga* sp., *Philautus* sp., *Polypedates leucomystax*, *Rana alticola*, *R. erythracea*, *R. lateralis*, *R. cf. limnocharis*, and *R. nigrovittata*.

TABLE 1. Measurements of type series of
Chirixalus punctatus. Mean (in mm) followed by
range (in parenthesis). Please see text for abbreviations.

	Males (N=21)	Females (N=6)
SVL	22.9 (21.5–25.0)	26.7 (24.7–28.4)
HL	8.0 (7.4–8.8)	9.2 (8.1–10.0)
HW	7.8 (7.1–9.5)	8.7 (7.5–9.6)
IND	2.4 (2.0–2.8)	2.7 (2.2–3.0)
IOD	3.1 (2.9–3.4)	3.5 (3.0–3.9)
SN	3.2 (2.8–3.5)	3.9 (3.4–4.2)
DNE	1.8 (1.5–2.7)	2.1 (1.6–2.4)
FLL	10.5 (9.6–11.9)	12.2 (10.8–12.9)
HL	6.6 (6.0–7.5)	7.5 (6.5–8.2)
THL	11.1 (9.8–12.6)	12.1 (11.3–12.6)
TIL	11.3 (10.5–12.3)	12.8 (11.9–13.8)
FL	9.6 (8.9–10.6)	10.9 (9.4–11.8)
3FDW	1.3 (0.9–1.7)	1.4 (1.3–1.6)
4TDW	0.9 (0.6–1.1)	1.0 (0.7–1.2)

DISCUSSION

As stated earlier, species of the genus *Chirixalus* are distinguished from other Asian rhacophorids by the presence of opposable fingers. Liem (1970) also suggested that the combination of an elongated vertebral column (2.4 times the width) and the absence of vomerine teeth, along with opposable fingers, can distinguish *Chirixalus* from other rhacophorids. However, many species of *Philautus* also lacked vomerine teeth and all possessed an elongated vertebral column (1.6 to 2.4 times the width) in Liem’s study. The close resemblance of species within *Chirixalus* to those within *Philautus* has prompted some researchers to either move some of the 13 species of *Chirixalus* into *Philautus* or not recognize *Chirixalus* as a genus separate from *Philautus* (Cochran 1927; Pope 1931; Bourret 1942; Taylor 1962). For example, *C. palpebralis* was originally assigned to *Philautus* by Smith (1924), even though he noted that the “first two fingers [were] partially opposed to the others” and though he considered it “most nearly related to *C. doriae*”. Based on these statements, Cochran (1927) and Pope (1931) did not recognize *Chirixalus* as a genus separate from *Philautus*. Taylor (1962) followed suit though he did suggest that *Chirixalus* may be recognized as a genus separate from *Philautus* based on the presence of opposable fingers. However, Bourret (1942) recognized *Chirixalus* as a genus separate from *Philautus*, but he did not place all current species into *Chirixalus* (i.e., *laevis* and *vittatus*). Finally, *C. palpebralis* was again assigned to *Chirixalus* by Inger et al. (1999), based on the presence of opposable fingers.

Recently, Bossuyt and Dubois (2001) tentatively assigned *C. cherrapunjiae* (Roonwal and Kripalani), *C. romeri* (Smith), and *C. shyamrupus* (Chanda and Ghosh) to *Chirixalus* based on the presence of a tadpole stage in *C. cherrapunjiae* and *C. romeri*, since, all species of *Philautus* are thought to be direct developers (Dring 1987), and because *C. shyamrupus* has longitudinal lines on the body, which they contend are not present in species of *Philautus*. Upon examining the figures and reviewing the text from the original descriptions, it is our view that *C. shyamrupus* is the only species to possess opposable fingers (Chanda and Ghosh 1989, Fig. 1) and thus should be assigned to *Chirixalus*. *Philautus romeri* and *P. cherrapunjiae* appear to lack opposable fingers (Smith 1953;



FIGURE 7. Paratype of *Chirixalus punctatus* (JBS 9274).

Roonwal and Kripalani 1961; Karsen and Lau 1986; Fei 1999). *Philautus roulei* may be a member of the new genus *Kurixalus* Ye, Fei, and Dubois, whereas *P. cherrapunjiae* may be a member of *Rhacophorus* but a determination will require examinations of the type specimens and observations of individuals in the field.

In a recent study of rhacophorid phylogeny, *Chirixalus* was the only paraphyletic genus (Wilkinson et al. 2002). Of five species of *Chirixalus* sampled (*C. doriae*, *C. eiffugi*, *C. idiootocus*, *C. palpebralis*, and *C. vittatus*), *C. eiffugi* and *C. idiootocus* formed a strong sister taxon relationship, separate from *C. doriae* and *C. vittatus*. The (*C. eiffugi*, *C. idiootocus*) clade formed a weaker relationship with members of *Philautus*, however, these two taxa shared only a few molecular and morphological characters with *Philautus* species (Wilkinson et al. 2002). Fei (1999) recently placed *C. eiffugi* into the new genus *Kurixalus*, and assigned *C. idiootocus* to *Philautus*. The results of the Wilkinson et al. (2002) study and the absence of opposable fingers in *C. eiffugi* and *C. idiootocus* led Wilkinson and colleagues to assign *C. idiootocus* along with *C. eiffugi* to *Kurixalus*. Their results also suggest a close relationship of *Philautus* and *Kurixalus*.

Chirixalus doriae formed a strong clade with *Chiromantis*, whereas *C. vittatus* formed a weak clade with *Polypedates* in the Wilkinson et al. (2002) study. *Chirixalus palpebralis* did not form a clade with any rhacophorid genus suggesting that it may be a representative of a heretofore unnamed genus.

It is interesting to note that as with species of *Chiromantis*, *Polypedates*, and *Rhacophorus*, *Chirixalus doriae* (the type species for this genus) constructs a foam nest. *Chirixalus punctatus* also constructs a foam nest. We therefore place *C. punctatus* within *Chirixalus* due to the presence of opposable fingers, the foam-nesting behavior, and other characters as described above but recognize the need for a systematic study of this genus that includes all known species and further evaluates their relationships with other rhacophorid genera.

We provide the following key to distinguish between ten species of *Chirixalus* (minus *P. cherapunjiae*, *K. eiffingeri*, *K. idiootocus*, and *P. romeri*) based on specimens we examined and original descriptions. We could not distinguish between *C. hansenae* and *C. vittatus*. One difference according to the original descriptions is a distinct tympanum in *C. hansenae* (Cochran 1927) and an indistinct (hidden) tympanum in *C. vittatus* (Boulenger 1887). However, we observed the tympanum to be indistinct in half of the specimens of *C. hansenae* that we examined, and we observed the tympanum to be distinct in one specimen of *C. vittatus* (MVZ 222098). We observed the tympanum on a paratype of *C. hansenae* (USNM 70110) to be distinct. Cochran (1927) based her description of *C. hansenae* on nine specimens. Of these nine, she reported that the tympanum in two specimens "is not so distinct because it is more nearly the color of the surrounding skin, although it can be readily outlined when the frog is placed in a different light". In addition, she compared these specimens with specimens of *C. palpebralis* and *C. doriae* but not with *C. vittatus*. Therefore, *C. hansenae* may be a junior synonym of *C. vittatus*, and the following key should be used with that caveat.

KEY TO THE SPECIES OF *CHIRIXALUS*

1. Longitudinal stripes on dorsum present 2
 Longitudinal stripes on dorsum absent 9
2. Dorsolateral stripes present 3
 Several dark longitudinal stripes present, distinct dorsolateral stripes absent 8
3. Tympanum distinct 4
 Tympanum indistinct 7
4. Inner metatarsal tubercle present 5
 Inner metatarsal tubercle absent, found in Arunachal Pradesh, India *shyamrupus*
5. Third and fourth fingers 1/4 webbed, found in Uttar Pradesh, India *dudhwaensis*
 No or very slight webbing on fingers 6
6. Disk on third finger as large as tympanum, 1/2 to 2/3 webbing on toes, indistinct
 metatarsal tubercle, found in east-central Thailand *hansenae*
 Disk on third finger smaller than tympanum, 1/3 webbing on toes, distinct oval
 metatarsal tubercle, found in Annam, Vietnam *laevis*
7. Dark spots on dorsum present, stocky body, broader head, larger toe disks, found in
 western Myanmar *punctatus*
 Dark spots on dorsum absent, slender body, narrower head, smaller toe disks, found
 throughout Southeast and East Asia *vittatus*
8. Snout obtusely pointed, skin smooth, glandular fold between eye and shoulder absent,
 found throughout South, Southeast, and East Asia *doriae*
 Snout truncated, skin of head with small round scattered warts, glandular fold between
 eye and shoulder present, found in northeastern India *sinus*
9. Tympanum distinct, interorbital space broader than upper eyelid, fingers distinctly
 opposable, blotched pattern on dorsum, white patch on side of upper jaw absent, found
 in Southeast Asia *nongkhorensis*
 Tympanum indistinct, interorbital space as large as upper eyelid, fingers only partially
 opposable, hourglass pattern on dorsum, white patch on side of upper jaw present,
 found in Annam, Vietnam and Yunnan, China *palpebralis*

MATERIAL EXAMINED

HOLOTYPE.— CAS 221555, adult male, collected at the Rakhine Yoma Elephant Wildlife Sanctuary Headquarters (17°36'48.8" N, 94°36'50.2" E), Gwa, Gwa Township, Rakhine State, Myanmar, 3 June 2001, by Htun Win, Thin Thin, Kyi Soe Lwin, and Awan Khwi Shein.

PARATYPES.— CAS 221553–221554, CAS 221556–221559, USNM 547928–547929, Joseph B. Slowinski (JBS) field numbers to be deposited in the MBM, JBS 8996, 8998–8999, 9201 seven adult males and five adult females, collected at the same locality and date as the holotype; CAS 221560, an adult male, from the De-Pok Village camp (17°53'35.5" N, 94°30'30.8" E), Gwa Township, Rakhine State, Myanmar, collected 4 June 2001 by Htun Win, Thin Thin, Kyi Soe Lwin, and Awan Khwi Shein; CAS 221561, 221964–221965, JBS 9231–9232, 9234, six adult males, from the De-Pok Village camp (17°53'50.1" N, 94°30'31.7" E), Gwa Township, Rakhine State, Myanmar, collected 4 June 2001 by Htun Win, Thin Thin, Kyi Soe Lwin, and Awan Khwi Shein; CAS 221562–221563, 221966, JBS 9237 four adult males, from the De-Pok Village camp (17°53'44.6" N, 94°30'30.8" E), Gwa Township, Rakhine State, Myanmar, collected 4 June 2001 by Htun Win, Thin Thin, Kyi Soe Lwin, and Awan Khwi Shein, and JBS 9274, 9276, two males, from the De-Pok Village camp (17°53'5" N, 94°30'23" E), Gwa Township, Rakhine State, Myanmar, collected 6 June 2001 by Htun Win, Thin Thin, Kyi Soe Lwin, and Awan Khwi Shein.

ADDITIONAL MATERIAL EXAMINED

Chirixalus doriae: China, NMNS 3183; Myanmar, CAS 210078–210083, 210085–210088, 210091–210094; Vietnam, ROM 32762, 32764, 32782–32783, 32884, 32915, 32951–32952, 33006, 33008. *Chirixalus eiffingeri*: Japan, CAS 211453–211458; Taiwan, CAS 211527–211531. *Chirixalus hansenae*: Thailand, FMNH 182568, 182572–182575, 182577, 182580–182584, 182586–182588, 182590–182591, USNM 70110. *Chirixalus idiotocous*: Taiwan, CAS 166031–166034, 211366, 211524–211526. *Chirixalus laevis*: Vietnam, ROM 30282. *Chirixalus nongkhorensis*: Myanmar, CAS 215915, 221564; Thailand, FMNH 172562–172563, 172567–172570, 182596, 182598–182602, 182607, 182610, 187518, 187519. *Chirixalus palpebralis*: China, NMNS 3104; Vietnam, MVZ 221980–221982, 221986–221987, 221989, 222008, 222010–222011, 222014. *Chirixalus vittatus*: China, NMNS 3184; Myanmar, CAS 221114–221115, 221212–221213, 221266–221267, 221293, 221565–221566; Vietnam, MVZ 222098, ROM 30338–30339, 30341, 30349, 30352, 30362–30363, 30369, 30381.

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